WHAT IS CLAIMED IS:

1. A method for mapping temperature rise of anatomical tissue using pulse-echo ultrasound, comprising the steps of:

a) obtaining a first signal of a first imaging ultrasound wave which has been reflected back from a region in the anatomical tissue at a first time;

b) obtaining a second signal of a second imaging ultrasound wave which has been reflected back from the region in the anatomical tissue at a later second time wherein the tissue has received at least some medical treatment by the second time;

c) computing first and second complex analytic signals from the first and second imaging signals;

d) computing the depth-dependent delay from the conjugate product of the first and second analytic signals;

e) generating an echo strain map from the slope of the depth-dependent delay;

f) using the echo strain map to estimate the amount of temperature rise from the first imaging signal to the second imaging signal; and

g) creating an image showing where temperature rise is occurring in the anatomical tissue.

2. The method of claim 1, further comprising the step of spatially filtering the difference signal.

3. The method of claim 2, further including the step of performing a thresholding operation to remove artifactual strain peaks.

4. The method of claim 1, further including the step of multiplying a signal of an ultrasound imaging wave by a phase compensation function to compute a correlation coefficient indicating the reliability of the temperature estimation.

5. The method of claim 4 wherein the signal is the first imaging signal.

6. The method of claim 5 wherein the signal is the second imaging signal.

7. The method of claim 4, further including the step of implementing windowed sums to provide a spatial map of the correlation coefficient.

8. The method of claim 7 wherein the windowed sums are two-dimensional.

9. The method of claim 1, wherein the echo strain map representing the slope of the depth-dependent delay assumes a linear relationship between echo strain and temperature rise.

10. The method of claim 1, wherein the echo strain map representing the depth-dependent delay assumes a non-linear relationship between echo strain and temperature rise.

END-5043

11. The method of claim 10 wherein the non-linear relationship is derived from measurements of non-linear relationships between temperature, sound speed and thermal expansion.

12. The method of claim 10 wherein the non-linear relationship is derived empirically from calibration measurements in the anatomical tissue.

13. The method of claim 1, wherein the medical treatment is ultrasound medical treatment.

14. The method of claim 1, also including steps a) through g) for different regions to image the anatomical tissue, wherein the image includes medically-treated and medically-untreated regions of the anatomical tissue.

15. A method for mapping temperature rise of anatomical tissue using pulse-echo ultrasound, comprising the steps of:

a) obtaining a first set of frames comprising a plurality of imaging ultrasound wave signals which have been reflected back from a region in the anatomical tissue during a first period of time;

b) obtaining a second set of frames comprising a plurality of imaging ultrasound wave signals which have been reflected back from a region in the anatomical tissue at a

later second time wherein the tissue has received at least some medical treatment by the second time;

c) averaging together the signals of the first set of frames to obtain an averaged first imaging signal;

d) averaging together the signals of the second set of frames to obtain an averaged second imaging signal;

e) computing first and second complex analytic signals from the first and second averaged imaging signals;

f) computing the depth-dependent delay from the conjugate product of the first and second analytic signals;

g) generating a strain map from the slope of the depth-dependent delay;

h) using the echo strain map to estimate the amount of temperature rise from the first averaged imaging signal to the second averaged imaging signal; and

i) creating an image showing where temperature rise is occurring in the anatomical tissue.

16. The method of claim 15, further comprising the step of spatially filtering the difference signal.

17. The method of claim 15, wherein the medical treatment is ultrasound medical treatment.

18. The method of claim 15, also including steps a) through i) for different regions to image the anatomical tissue, wherein the image includes medically-treated and medically-untreated regions of the anatomical tissue.

19. A method for mapping temperature rise of anatomical tissue using pulse-echo ultrasound, comprising the steps of:

a) obtaining a first set of frames comprising a plurality of imaging ultrasound wave signals which have been reflected back from a region in the anatomical tissue during a first period of time;

b) obtaining a second set of frames comprising a plurality of imaging ultrasound wave signals which have been reflected back from a region in the anatomical tissue at a later second time wherein the tissue has received at least some medical treatment by the second time;

c) computing complex analytic signals from a selected frame from the first set of frames and a selected frame from the second set of frames;

d) computing the conjugate product of the complex analytic signals of step c);

e) repeating steps c) and d) until conjugate products have been computed for all of the frames of the first and second frame sets;

f) computing the average of the conjugate products of step e);

g) computing the depth-dependent delay from the averaged conjugate product of step f);

h) generating an echo strain map from the slope of the depth-dependent delay;

i) using the echo strain map to estimate the amount of temperature rise from the first averaged imaging signal to the second averaged imaging signal; and

j) creating an image showing where temperature rise is occurring in the anatomical tissue.

20. A method for mapping temperature change in anatomical tissue using pulse-echo ultrasound, comprising the steps of:

a) obtaining a set of frames comprising a plurality of imaging ultrasound wave signals which have been reflected back from a region in the anatomical tissue during a period of time;

b) computing complex analytic signals from the set of frames;

c) computing the conjugate product of a pair of adjacent frames of the set of frames;

d) repeating step c) until the conjugate products of all adjacent frames have been computed;

e) averaging the conjugate products of the adjacent frames of step d);

f) computing a depth-dependent delay map from the average conjugate product;

g) generating an echo strain map from the slope of the depth-dependent delay;

h) using the echo strain map to estimate the amount of temperature change from the first frame to the second frame; and

i) creating an image showing where temperature change is occurring in the anatomical tissue.

21. A method for mapping temperature rise of anatomical tissue using pulse-echo ultrasound, comprising the steps of:

a) obtaining a first signal of a first imaging ultrasound wave which has been reflected back from a region in the anatomical tissue at a first time;

b) obtaining a second signal of a second imaging ultrasound wave which has been reflected back from the region in the anatomical tissue at a later second time wherein the tissue has received at least some medical treatment by the second time;

c) computing first and second complex analytic signals from the first and second imaging signals;

d) computing the depth-dependent delay from the conjugate product of the first and second analytic signals;

e) generating an echo strain map from the slope of the depth-dependent delay;

f) using the echo strain map to estimate the amount of temperature rise from the first imaging signal to the second imaging signal;

g) creating an image showing where temperature rise is occurring in the anatomical tissue; and

h) repeating the method at least once by:

i) re-defining the second imaging signal obtained at step b) as the first imaging signal of step a);

ii) obtaining a new second imaging signal at step b); and

ii) repeating steps c) through g).